

1 CLAIMS

2 We claim:

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4 1. A micro-pump comprising:

5 a first layer having:

6 an inlet recess;

7 an inlet channel in fluid communication with the inlet recess; and

8 an outlet channel;

9 a second layer having:

10 an outlet; and

11 an inlet;

12 wherein the first layer and the second layer are disposed such
13 that the inlet is opposite the inlet recess and at least a portion of the
14 outlet channel is opposite the outlet and wherein at least one of the first
15 layer and the second layer includes a pumping chamber in fluid
16 communication with the inlet channel and the outlet channel; and
17 a third intermediate flexible layer having:

18 an inlet slit and an outlet slit positioned therein;

19 an actuatable portion abutting the pumping chamber;

20 a first valve portion adjacent the inlet slit, wherein the first valve
21 portion is disposed over the inlet to block fluid passage between the
22 inlet and the inlet recess and wherein the first valve portion is moveable
23 away from the inlet in response to a first actuation of the actuatable
24 portion to allow the inlet to be in fluid communication with the inlet
25 recess through the inlet slit; and26 a second valve portion adjacent the outlet slit, wherein the
27 second valve portion is disposed between the outlet channel and the
28 outlet so as to block fluid passage between the outlet channel and the
29 outlet and wherein the second valve portion is moveable away from the
30 outlet channel in response to a second actuation of the actuatable

1 portion to allow the outlet channel to be in fluid communication with the
2 outlet through the outlet slit.

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4 2. A micro-pump according to Claim 1, wherein the pumping chamber is defined
5 by two respective pumping recesses in the first layer and the second layer, and
6 wherein the actuatable portion of the intermediate flexible layer is arranged between
7 the pumping recesses.

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9 3. A micro-pump according to Claim 1, wherein inlet of the second layer
10 comprises a recess surrounding a pedestal, the pedestal being in abutment with the
11 inlet slit of the intermediate flexible layer.

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13 4. A micro-pump according to Claim 1, wherein the outlet channel of the first
14 layer comprises a recess surrounding a pedestal, the pedestal being in abutment with
15 the outlet slit of the intermediate flexible layer.

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17 5. A micro-pump according to Claim 1 wherein the inlet slit and the outlet slit are
18 respective through-holes in the intermediate flexible layer.

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20 6. A micro-pump according to Claim 1, wherein the intermediate flexible layer
21 comprises a polymeric material.

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23 7. A micro-pump according to claim 6, wherein the polymeric material is selected
24 from the group consisting of polycarbonate, polyacrylic, polyoxymethylen, polyamide,
25 polybutyleneterephthalat and polyphenylenether.

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27 8. A micro-pump according to claim 6, wherein the intermediate flexible layer is a
28 membrane.

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1 9. A micro-pump according to Claim 8, wherein the membrane comprises a
2 material selected from the group consisting of polydimethylsiloxane, mylar,
3 polyurethane fluoride, and flourosilicone.

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5 10. A micro-pump according to Claim 1, wherein the intermediate flexible layer is a
6 unitary layer.

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8 11. A micro-pump according to Claim 1, wherein the intermediate flexible layer is
9 at least substantially flat.

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11 12. A micro-pump according to Claim 1, wherein a through-hole is defined in one
12 of the first layer and the second layer to be in fluid communication with the pumping
13 chamber.

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15 13. A micro-pump according to Claim 1, wherein the first layer and the second
16 layer are molded.

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18 14. A micro-pump according to Claim 1, further comprising an actuator disposed in
19 the pumping chamber for actuating the actuatable portion of the intermediate flexible
20 layer.

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22 15. A micro-pump according to Claim 14, wherein the actuator is a bimorph PZT
23 cantilever.